The Lightcurve of Pluto Post New Horizons

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Discovered in 1930, Pluto is a unique dwarf planet that has challenged and inspired the minds of many. It is a key object in the third zone out from our Sun and provides important insight to formation and collisional processes that were at work in the original solar nebula. In July 2015 the New Horizons spacecraft (a NASA mission) will encounter this small, dark, icy world and the family of objects that orbit it providing a once-in-a-lifetime opportunity to directly link our Earth-based view of Pluto with 'ground truth' provided by in situ measurements. However, this encounter will be short-lived compared to other planetary voyages because it is unfeasible to slow the spacecraft down to orbit within the Pluto system; instead this visit will be a flyby. Studies from Earth-based or Earth-orbit facilities prior to and post encounter will provide critical baseline and context information for optimal interpretation of the valuable flyby science data.

Pluto is known to be a constantly changing world due to the solar energy being received decreasing by ~2% per year on account of its eccentric orbit now carrying it rapidly away from perihelion. What's more, the orientation of Pluto's spin axis and the sub-solar latitude (the height of the "midday Sun") changes by more than 1 degree per Earth year, bringing 100,000 square kilometers of new surface area into sunlight for the first time in a century (while casting an equal and opposite polar area into a century long arctic winter). These orbit-related effects on the atmosphere and surface of Pluto are on top of the well-known longitudinal variations measurable over the course Pluto's 6.387 day rotation. Observations of Pluto one year prior-to and post-flyby will allow us to identify evolving trends in the system which could be missed if we focused on only the flyby dataset. Our ultimate goal is to better understand Pluto, its family of satellites and their evolution since formation.

We propose to observe the Pluto system, which is on silicon in the selected Campaign 7 K2 field. These observations will take place after New Horizons has completed its flyby and will provide a key baseline of photometric observations that are not available from ground-based observatories because of Pluto's position relative to Sun during the timeframe of this campaign (Oct-Dec 2015). Pluto is relatively bright, MV~14, but not overly bright, so it is an ideal object for the K2 set-up. The positional uncertainty of Pluto over the observing period is less than a Kepler pixel providing star-like PRFs in a single K2 observation. Therefore, monitoring Pluto, which moves only a few arcminutes per night, requires a target pixel mask over its path on the FOV. Pluto's rotation period is 6.387 days so the collected 30-min integration "long cadence" datapoints will provide measurements of nearly 12 full rotations of Pluto and its companions. Likewise, the 3-month baseline also allows us to sample seasonal variations and solar phase angles ranging from 1.7°-0.2° during Campaign 7. The continuous 30-minute sampling interval provides a time resolution not possible from any other observatory. Some complications for interpreting the dataset will result from the large pixel scale, but the high sampling density will allow for disentanglement of the individual Pluto-Charon lightcurves.

This will be the highest resolution Earth-centered dataset of the Pluto system ever collected and will provide critical long time baseline photometry for tying the New Horizons sub-disk photometry to disk integrated observations. This dataset is critical for our continued study of Pluto's evolving surface-atmosphere interaction as it recedes from the Sun and of the influence of Pluto and Charon on each other. It will also provide insight for interpretation of other dwarf planets and Kuiper Belt objects in the third zone of our Solar System.